

New paper on a crystallographically-based constitutive model of single crystal and polycrystal deformation by climb and glide

A paper by Ricardo Lebensohn, Carlos Tomé (MST8) and coauthors will appear in the next issue of Philosophical Magazine. This work, done within the context of the Advanced Fuel Cycle Initiative (AFCI) program on cladding materials for the new generation of nuclear reactors, presents a crystallographically-based constitutive model of single crystal deformation by climb and glide. The proposed model is an extension of the widely-used crystal plasticity approach by dislocation glide. Based on this novel description of the high-temperature plastic deformation of single crystals under tension, Lebensohn, Tomé and coworkers developed a polycrystal model for aggregates deforming in a climb-controlled thermal creep regime, and implemented it numerically inside the ViscoPlastic Self-Consistent (VPSC) code. VPSC is a polycrystal plasticity computer code, developed and maintained in LANL, and used by numerous R&D groups worldwide, as a predictive tool for parameter identification, interpretation of experimental results and multiscale calculations of material behavior. The present extension of VPSC to the climb-and-glide regime is part of an on-going effort by these MST-8 researchers to develop a physically-based continuum model of under-irradiation mechanical behavior of materials for civil nuclear applications, accounting for mechanisms like thermal creep, irradiation creep and swelling. Besides the prediction of the mechanical behavior of materials under irradiation, the proposed model can also be applied to other problems in which thermal creep represents an important deformation mechanism. In particular, Lebensohn et al's article illustrates the capabilities of the new approach using examples relevant to Geophysics and Physical Metallurgy, of calculations of the effective behavior of olivine (the mineral that makes the majority of the Earth's upper mantle), and of texture evolution of aluminum deformed at warm temperature and low strain rates, respectively. In both cases, the addition of climb as a complementary single-crystal deformation mechanism improves the polycrystal model predictions.